REMARKS

Claims 1-14 are currently pending in the application, and Claims 1-14 currently stand rejected. By this Amendment, Claims 7-9 have been cancelled, Claims 1-6 and 8-14 have been amended, and Claims 15-21 have been added. In view of the amendments and below remarks, it is respectfully submitted that the application is in condition for allowance.

Substitution of Title

The Office has objected to the title of the invention as being non-descriptive. The previous title has been substituted with a more descriptive title.

Objection to the Disclosure

The Office has objected to the teaching of the specification that a "wide range" of quaternary ammonium compounds are useful when viewed in the light of the comments regarding the patent to Lewenstein (on page 2, the last two paragraphs). In this regard, the Office states that it appears that not all quaternary ammonium compounds provide the functions relative to the conditions applied to the electrochemical cell of the instant claims.

In the reference to Lewenstein, it is not stated that the quaternary ammonium compounds disclosed therein would not work in the present invention. Rather, the reference to Lewenstein indicates that the quaternary ammonium compounds are included in the electrolyte in order to suppress gas evolution through minimizing the latent chemical reactions between the electrolyte and the antimony-to-lead couples existing in one of the electrodes. In other words, the inclusion of the quaternary ammonium compounds are to prevent the local action of gas evolution whilst the battery is being stored or in use.

Lewenstein is silent on whether or not the quaternary ammonium compounds can be used when a potential sufficient to cause electrolysis, as recited in the claims, is applied to the electrochemical cell in order to reduce such electrolysis and, hence, water loss. Therefore, it is not incorrect to state that a wide range of quaternary ammonium compounds are useful under the conditions specified and claimed, and Applicant respectfully requests that this objection be withdrawn.

Rejection Under 35 U.S.C. §112, second paragraph

Claims 1-14 stand rejected un 35 U.S.C. §112, second paragraph for a variety of terms and phrases which lack antecedent basis. The claims have been amended to overcome the rejections.

Rejections Under 35 U.S.C. §102(b)

Claims 1-14 stand rejected under 35 U.S.C. §102(b) in view of JP 10-302785 A (JP '875), JP 50-09178 (JP '178), and US 3,877,993 (US '993). The claims have been amended in order to more particularly point out features of the claimed invention not disclosed in the cited references. In particular, the claims have been amended to specify that the "additive" is a current impeding medium that creates a resistive path to the flow of a current between the electrodes when a potential sufficient to cause electrolysis is applied across the electrodes. Basis for the addition may be found on page 24 of the specification.

The effect of the current impeding medium in reducing electrolysis is only being claimed in a condition where electrolysis is taking place, i.e. at a potential above the so-called gassing potential or threshold potential of the electrochemical cell. None of the cited documents disclose or suggest, alone or in combination, that the electrolytic process of an electrochemical cell can be manipulated to provide for reduced water loss and, perhaps more importantly, longer electrode life. The references are addressed individually below.

Rejection Under 35 U.S.C. §102(b) in view of JP 10-302785A

Claims 1, 2 and 6 - 13 stand rejected in view of the JP '785 reference. JP '785 discloses an electrochemical cell comprising opposed positive and negative electrodes and an electrolyte in ionic contact with the electrodes. Stearic acid or a salt thereof is added to the electrode paste prior to forming the negative electrode, forming a fatty acid film on an active material surface of the electrode. The stearic acid or salt forms an integral part of the negative electrode. Consequently, the effect of the fatty acid film is seen throughout the charging and discharging cycle of the battery. As a result, while the film may have the effect of raising the hydrogen overvoltage, which manifests as a reduction in the charge current at a constant voltage charge, the film negatively affects the discharging capacity of the battery, as conceded by the patentees under the paragraph entitled "Solution" of the abstract.

In particular, a drop in the discharge capacity increases with an increase in the amount of added fatty acid, and greatly so when exceeding 2%. Accordingly, the incorporation of stearic acid or a salt thereof results in a sacrifice in the discharge capacity of the battery in order to reduce water loss, i.e. there is a trade off between a loss in discharge capacity and a reduction in water loss.

In addition to the above, the thrust of JP '785 is to raise the hydrogen overvoltage in order to suppress the hydrogen generating reaction during overcharging. In other words, the aim is to prevent the hydrogen generating reaction from taking place.

By contrast, the present invention recites that a potential be applied across the electrochemical cell which is sufficient to cause electrolysis and hence hydrogen generation. Under these conditions, it has surprisingly been found that the current impeding medium of the invention provides a resistive path in the electrolyte which reduces, but does not stop, the amount of electrolysis taking place. As a result of the arrangement of the desired compound around the negative electrode, gas bubbles emanating from the negative electrode are trapped so as to form the resistive path.

In contrast to the cited reference, the formation of the resistive path in the claimed invention is dependent on the cell operating in the electrolytic conditions claimed, it has no deleterious effect on the conventional charging and discharging capacity of the electrochemical cell and has been found to improve the discharging capacity of the cell. See page 21, last paragraph, and from page 23, last paragraph to page 25, first paragraph of the specification.

The term "overcharging" used in the reference is not equivalent to "a potential ordinarily sufficient to cause electrolysis". While "overcharging" relates to charging a cell above a point at which the acidic density and voltage show no increase at a given temperature, "electrolysis" is the electrochemical decomposition of a substance through passage of a current to convert electrical energy to chemical energy.

The term "film" used in the reference is not equivalent to a barrier or impediment for gas evolution from the negative electrode as claimed in the instant invention. There is nothing in the reference to suggest that the film acts as a barrier or impediment. To the contrary, the patentee of the '785 reference equates the film to a so-called "negative electrode activation material", which is opposite in meaning to that of a barrier or impediment.

By definition, the resistive path of the claimed invention only comes into being above the so-called threshold potential (otherwise it would not obey ohms law), which is not discussed or even suggested in JP '785. Therefore, it is respectfully submitted that the claims, as amended, are neither taught nor suggested by the JP '785 reference, alone or in combination with the other references.

Rejection Under 35 U.S.C. §102(b) in view of JP 50-091728

Claims 1 - 7 and 9 - 14 stand rejected in view of the JP '728 reference. JP '728 discloses an alkaline battery having opposed positive and negative electrodes with an aqueous electrolyte in ionic contact with the electrodes. A benzyl group containing quaternary ammonium salt is added to the anode active mass and/or the electrolyte to improve the charging and discharging characteristics of the alkaline battery. An example of the additive is 3.0% dodecyldimethylbenzylammonium chloride. The Office regards this compound as a "current reducing additive".

It is well known that cyclic substituents such as aromatic aldehydes, quaternary pyridiniums and the like are used traditionally by electroplaters to control zinc dendrite growth or zinc deposition in electroplating processes. Dodocyldimethylbenzylammonium chloride is such a compound. Rather than acting as a current reducing additive, it is submitted that this compound controls the zinc depositioning on the negative electrode during the conventional charging and discharging cycles of a zinc alkaline battery, thereby improving the operation of the battery.

There is no teaching or suggestion in JP '728 that the dodecyldimethylbenzylammonium chloride can be used as a current impeding medium for reducing electrolysis when a potential sufficient to cause electrolysis is applied to the electrochemical cell. In this regard, it is believed that in an overpotential state, the zinc plating on the negative electrode, notwithstanding the inclusion of dodecyldimethylbenzylammonium, would be too great and the cell would not operate properly, if at all.

Finally, the improvement in the charging and discharging of the alkaline cell of JP '728 is believed to be related to the conventional process currents in operation, i.e. below the threshold at which electrolysis takes place, and not the so-called electrolytic currents as indicated in the present invention.

In view of the amendments and remarks above, the claims of the application are neither taught nor suggested by the JP '728 reference, alone or in combination with the other references. Particularly, because JP '728 does not teach or suggest that the dodecyldimethylbenzylammonium chloride can be used as a current impeding medium for reducing electrolysis when a potential sufficient to cause electrolysis is applied to the electrochemical cell as recited in the present claims.

Rejection Under 35 U.S.C. §102(b) in view of US 3,877,993

Claims 1, 2, 6, 7 and 9 - 14 stand rejected in view of the US '993 reference. The electrochemical cells disclosed in this reference are so-called "dry cells" or "LeClanche" cells which are primary cells, and persons skilled in the art would not expect a potential to be applied across these cells to cause electrolysis. This is particularly so since this type of cell cannot be recharged: once the cell reaction has reached equilibrium, the cell is discarded.

There is no indication in the US '993 reference that the quaternary ammonium compounds are included as a current reducing additive or impeding medium which creates a resistive path when a potential sufficient to cause electrolysis is applied to the electrochemical cell. Further, the reference discloses five specific polymerized quaternary ammonium salts that are said to reduce the rate of attack by the aqueous portion of the electrolyte on the zinc in a LeClanche type dry cell. By contrast, it is stated that a number of quaternary ammonium chloride type compounds had no effect or even increased the rate of attack on the zinc in a LeClanche type dry cell. Thus, materials having very similar properties to the specified five compounds do not show the benefits of the selected additives. In particular, monomeric quaternary ammonium salts were found to be poor materials in the context of US '993.

In addition to the above, the thrust of US '993 is to prevent or reduce attack on the zinc anode whilst the battery is being stored or in use. Once again, this reference deals with local action, and not action under the application of a current. There is no indication that it would have this effect if the cell was to be placed in an "overpotential state" although, as mentioned previously, this would in any event not be expected.

For the reasons stated above, the claimed invention is novel and non-obvious over the US '993 reference alone or in combination with the other cited references. Particularly because the US '993 reference does not disclose or suggest a current impeding medium that provides through contact with the electrolyte a resistive path in a flow of a current between the electrodes when a potential sufficient to cause electrolysis of the electrolyte is applied across the electrodes, as claimed in the instant application.

Double Patenting

Claims 1-3 and 6-14 have been provisionally rejected under the judicially created doctrine of obviousness-type double patenting. Applicant requests that the Office reconsider this rejection in view of the amendments to the Claims made herein. In the event the double patenting rejection stands, Applicant would consider filing a terminal disclaimer.

It is submitted that all rejections have been overcome in view of the amendments and remarks herein. It is requested that the Office enter the amendments and find the pending claims to be allowable.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefore (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,

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Version with Markings to Show Changes Made:

1. (Once amended) An electrochemical cell comprising opposed positive and negative electrodes[,] and an aqueous electrolyte in ionic contact with the electrodes, the electrochemical cell being disposed to cause electrolysis when a sufficient amount of potential is applied across the electrodes, the electrochemical cell further comprising [and] a current [reducing additive] impeding medium that provides through [in ionic] contact with the electrolyte a resistive path [and the electrodes, the current reducing additive being capable of reducing the] in a flow of a current between the electrodes when a potential [ordinarily] sufficient to cause electrolysis of the electrolyte is applied across the electrodes, thereby to reduce the flow of the current between the electrodes and consequently reducing the amount of electrolysis [of the electrolyte].

2. (Once amended) An electrochemical cell according to claim 1, wherein the current [reducing additive] impeding medium is selected from the group comprising quaternary ammonium compounds including n-alkyl dimethyl benzyl ammonium chloride, didecyl methyl oxyethyl ammonium propionate, pyridine and quinoline, non-ionic compounds including primary, secondary and tertiary amines, and anionic compounds including sodium dioctyl sulpho succinate, the anionic compounds being [provided the latter are] included in the presence of suitable cations.

3. (Once amended) An electrochemical cell according to claim 2, wherein the current [reducing additive] impeding medium is n-alkyl dimethyl benzyl ammonium chloride, the alkyl group having n carbon atoms, n being an integer from 12 to 16.

6. (Once amended) A method of reducing water loss in an electrochemical cell of the type having opposed positive and negative electrodes and an electrolyte in ionic contact with the electrodes, and being disposed to cause electrolysis of the electrolyte when a sufficient amount of a potential is applied across the electrodes, the method

[includes] including the steps of introducing into the cell a current [reducing additive] impeding medium that provides through contact with the electrolyte a resistive path in a flow of a [into the electrolyte of the cell to reduce the] current between the electrodes [of the cell] when a potential [ordinarily] sufficient to cause electrolysis of the electrolyte is applied across the electrodes, and applying sufficient potential to cause electrolysis of the electrolyte across the electrodes to activate the current impeding medium into providing a resistive path to the flow of a current between the electrodes, thereby reducing [to reduce gas evolution at the electrodes and, consequently, water loss] electrolysis of the electrolyte.

10. (Once amended) A method according to claim 6, wherein the current [reducing additive] impeding medium additionally forms an impediment or barrier at the negative electrode to ions being attracted to the negative electrode or gas bubbles evolving from the negative electrode.

11. (Once amended) A method according to claim 10, wherein the ions being attracted to the negative electrode are hydrogen ions and the gas bubbles evolving from the negative electrode are hydrogen bubbles.

12. (Once amended) An electrochemical cell comprising opposed positive and negative electrodes[,] and an aqueous electrolyte in ionic contact with the electrodes, the electrochemical cell being disposed to cause electrolysis of the electrolyte when a sufficient amount of a potential is applied across the electrodes, the electrolysis being caused by a flow of current between the electrodes and being accompanied by a flow of ions to the negative electrode and/or a flow of bubbles from [and a current reducing additive in ionic contact with the electrolyte and the electrodes, the current reducing additive being arranged to adhere or adsorb to] the negative electrode, the electrochemical cell further comprising a current impeding medium that provides through contact with the electrolyte [and to form] an impediment or barrier over a surface of the

negative electrode when a sufficient potential [ordinarily sufficient] is applied across the electrodes to cause electrolysis of the electrolyte [is applied across the electrodes], the impediment [barrier] or barrier [impediment] providing at least one of: [effect selected from the group comprising] (a) a reduction in the flow of current [to] between the electrodes[,]; (b) a reduction in the flow of ions to the negative electrode [and]; or (c) a reduction in the flow of gas bubbles from the negative electrode.

13. (Once amended) An electrochemical cell according to claim 12, wherein the current [reducing additive is arranged to inhibit] impeding medium traps gas bubbles evolving from the negative electrode to form the impediment or barrier.

14. (Once amended) An electrochemical cell according to claim 13, wherein the current [reducing additive] impeding medium includes a head portion [for adhering or adsorbing] that is attracted to the negative electrode and a tail portion extending away from the head portion, the tail portion being arranged to trap the gas bubbles evolving at the negative electrode.